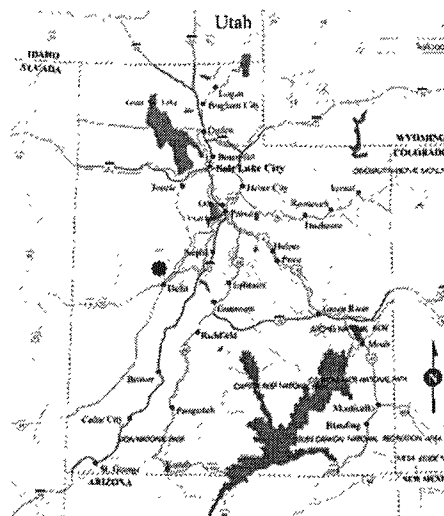
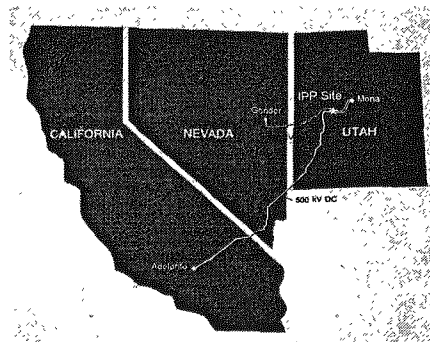


Intermountain Power Project

- **LOCATION-**
West- central Utah



IPP Background

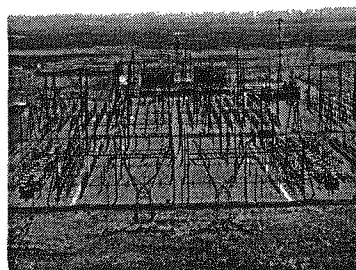
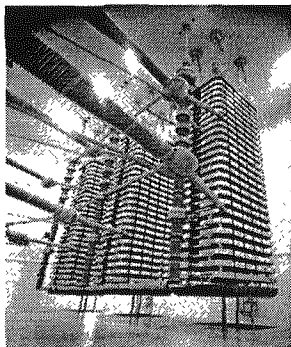
- Intermountain Generating Station (2 units)
- Southern Transmission System (AC, DC & ICS)
- Railcar Service Center (own and maintain 2 unit trains)
 - Utah- own water rights, plus coal mining rights
 - Site- zero discharge, sludge conditioning
 - Sale Fly Ash to contractor (ISG)



Transmission Systems

AC Transmission

- AC Switchyard
- 345 KV Transmission
Line to Mona, Utah



DC Transmission

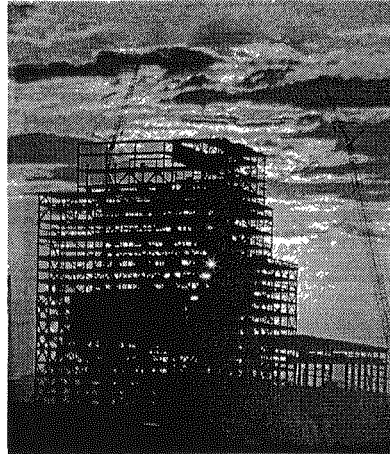
- DC Converter Station
- 500 KV Transmission
- 500 mile DC Line to Adelanto, CA

6

Plant History

Construction

- Black & Veatch- A/ E
- Bechtel- const manager
- Construction began in 1982
- Unit 1 Commercial Oper 1986
- Unit 2 Commercial Oper 1987



7

Plant Capacity- Uprate History

Unit Output Rating

- GE Turbine nameplate rating 820 MW
- Original Unit Rating 840 MWgross
- 1995 Uprated to 865 MW (2 season)
- 1996 Uprated to 875 MW (year round)
- Phased Up-Rate '02-'04 to 950 MW

8

Upgrading Aging Power Stations

Basis of Enhancements

- Always “Pushing it to the Edge” to get maximum generation
- At times, necessary to “Redefine the Edge” to take it to that next level
- Must evaluate systems to determine “where is the edge”:
 - Turbine & Turbine Cycle + Generator
 - Replaced HP Turbine w/ more efficient & increased flow
 - Boiler MCR- does it have extra capacity?
 - In our case, converted Overpressure mode to additional steam flow at rated pressure conditions
 - Heat Rejection System
 - Added Helper Cooling Tower to help reduce CCW temp and backpressure
- Evaluate the RISKS
 - Talked to OEMs and conducted modeling

9

Plant Enhancements

Basis for Turbine & Boiler Improvements

- HP Turbine Upgrade
 - replaced HP rotor (w/ additional stage) and inner shell, in the existing outer shell
 - recover lost turbine perf from solid particle erosion (in HP)
 - improve efficiency with new turbine “dense pack” design
 - increase turbine steam flow passing capability for additional megawatts (open up areas in HP)
- Steam Generator Upgrade
 - utilize the 5% overpressure flow capability available
 - original design allowed small additional flow increase by minor drum mods and adding 1 main steam safety valve (converted ERV)
 - added SSH platen area by extending tubes

10

Upgrade Decision- Justification

Need for Additional Power

- California Energy Shortage & Crisis
- Increased Energy Prices

HP Turbine Upgrade

- 190 \$/KW Construction Cost vs 1000 \$/KW for New Facility
- 8% recovery & increase in HP Turbine efficiency
- 1.4% increase in Overall cycle efficiency
 - Efficiency Improvement Justifies Upgrade
- Bonus & Kicker
 - 140 MWnet Additional Station Capacity

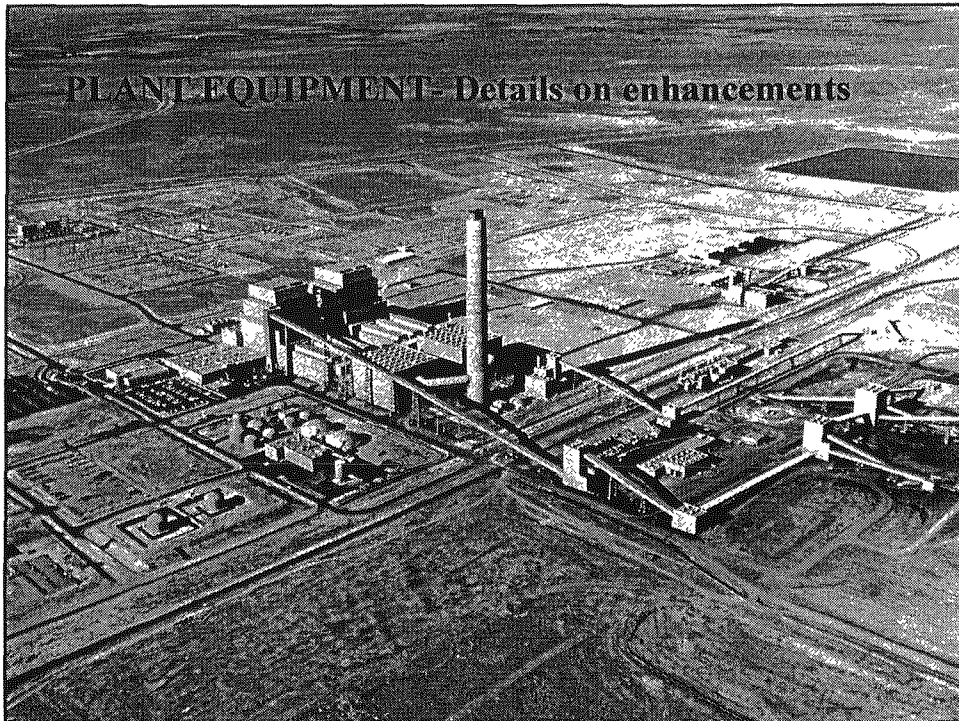
11

Station Capacity- Schedule

Details of Plant Improvements

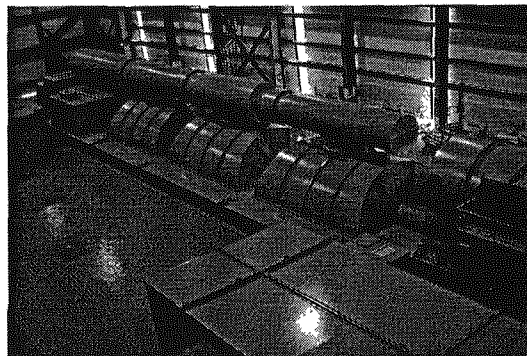
- Phase 1- IGS Unit 2 uprated to 900 MWgross (from 875 MWgross) on 5/24/02 as an interim load until final boiler modifications could be performed in 3/2004 Outage
- Phase 2- IGS Unit 1 was uprated to 950 MWgross following the Spring 2003 Outage (after startup tuning, performance testing and State required testing)
- Phase 3- IGS Unit 2 has been uprated to 950 MWgross following the Spring 2004 Outage (after startup setup, tuning and testing)

12



Turbine- design

- General Electric “S2”
- Tandem Compound,
6 Flow Reheat Turbine
- 1 HP, 1 IP & 3 LP Turbines
- Baseloaded operation



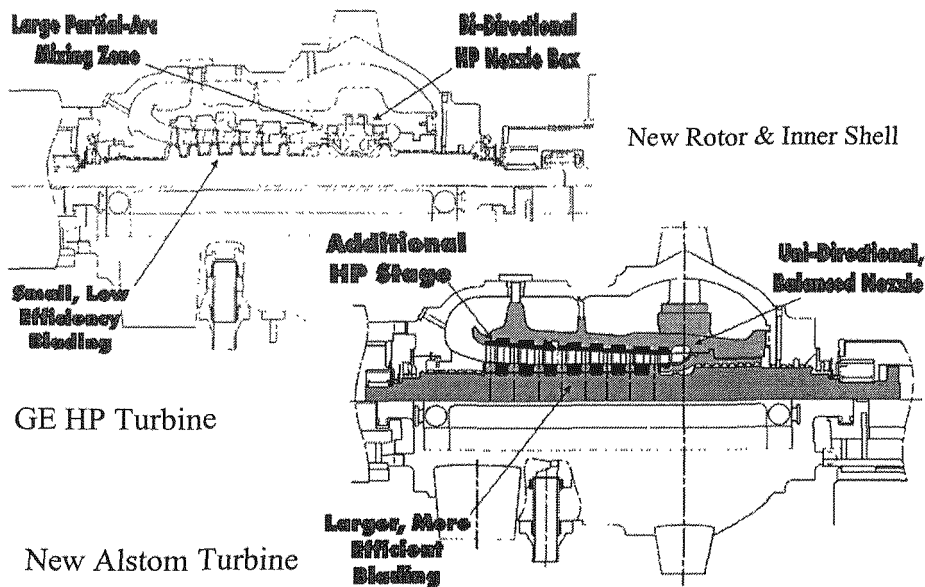
HP Turbine- upgrade

Purchase Decision

- General Electric & Alstom Proposals
- Alstom chosen due to schedule, cost and performance
- Installation during 4-Week Outage
- Performance guarantee for HP efficiency, flow, and output capacity
- Contract Incentives and Penalties for both schedule and performance

15

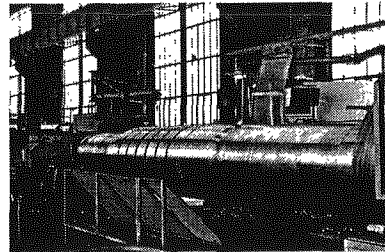
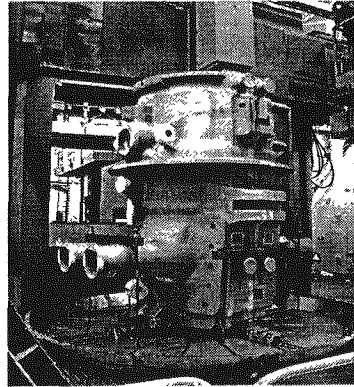
HP Turbine- upgrade



HP Turbine- upgrade

Construction:

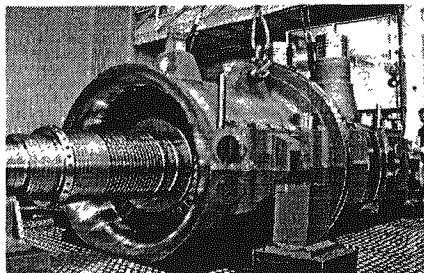
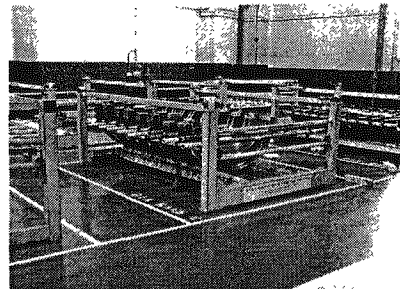
- Rotors forged in Germany and machined in England
- Inner shells cast in Poland and machined in England



HP Turbine- upgrade

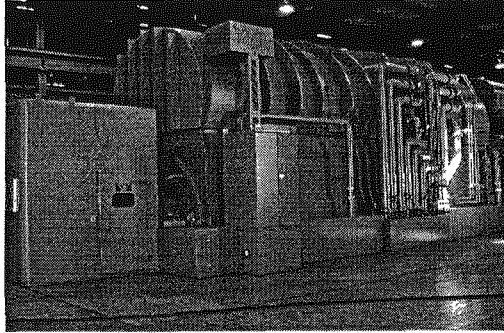
Construction:

- Diaphragms Fabricated and Machined in England
- Testing, Assembly and Final Preparation in England
- Fabrication- 11 Months
- Shipping- 3 Weeks

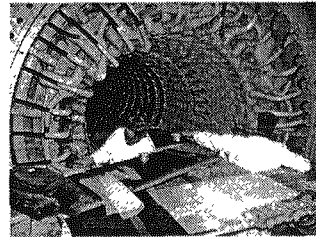


Generator- design

- General Electric
- 2-Pole, 3-Phase, 60 Hertz
- Water Cooled Conductor, Synchronous Generator
- 991 MVA Rating



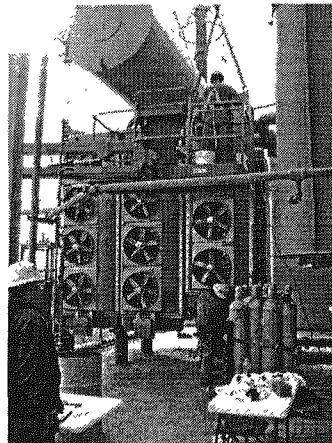
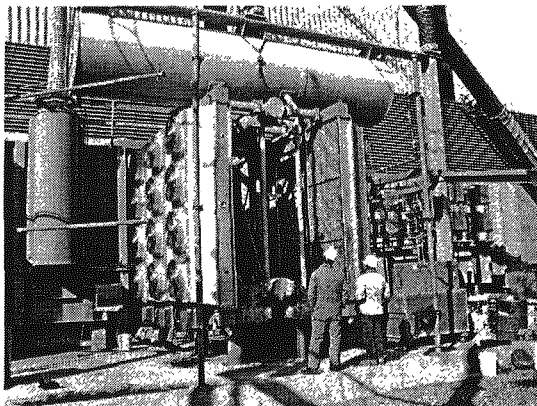
Future- Rewind due to stator bar clip to strand issues (separate discussion)



19

Step-Up Transformer- upgrade

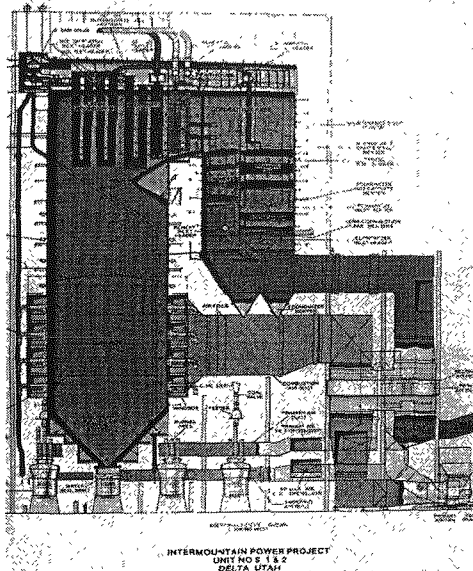
- Oil cooling upgrade



20

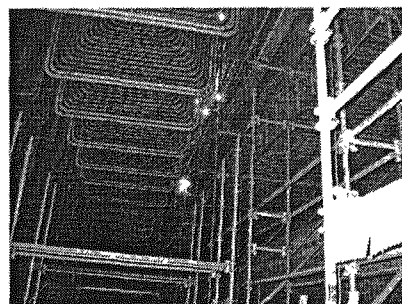
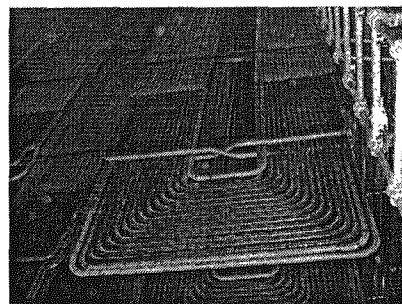
Steam Generator- design

- Babcock & Wilcox
- Balanced draft
sub-critical drum
- Opposed fired
- 6,600,000 lbs/hr



Boiler- modifications

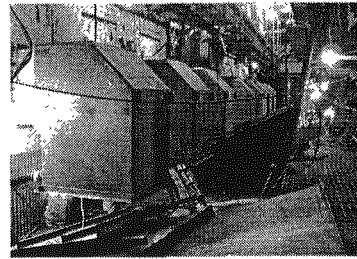
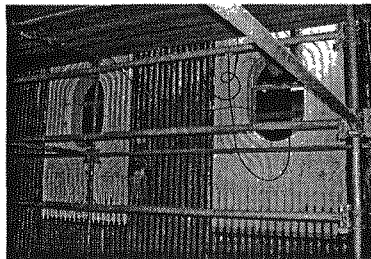
- Concerns- controllability
of superheat outlet temps
- Modeling- best location
extended SH Platen tube banks
- Boiler safety valve relief capacity
- Additional capacity required
 - conversion of electromatic RV
(1 of 2 available) to standard
safety spring valve



22

Overfire Air System- addition

- Concerns- reducing NOx levels and coal quality issues
- Babcock Power, Inc (BPI)
- Opposed- 2 rows front & rear, 8 ports, (16 ports total)
- Flow control- 1/3, 2/3 & isolation dampers

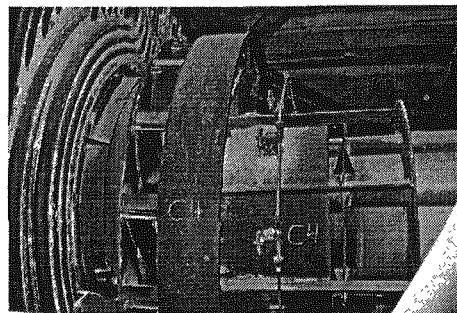


23

Burners- design

- Babcock & Wilcox
- Low NOx Dual Register
- Opposed Fired- 4 rows front & rear, 6 burners (48 burners total)

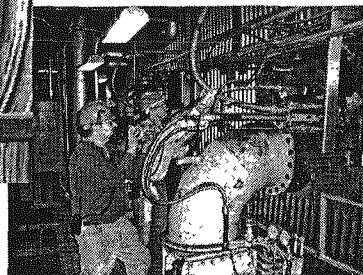
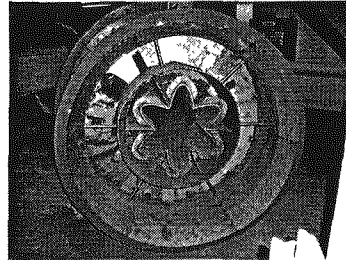
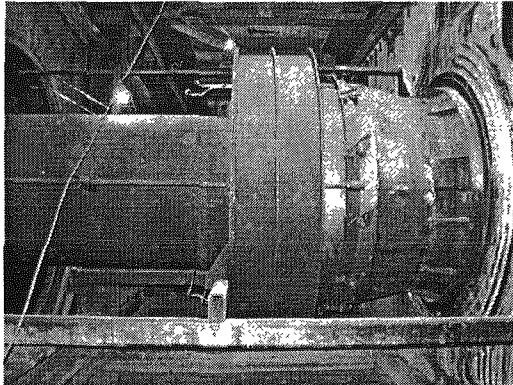
U2 Burner upgrade,
U1 previously upgraded
(separate discussion)



24

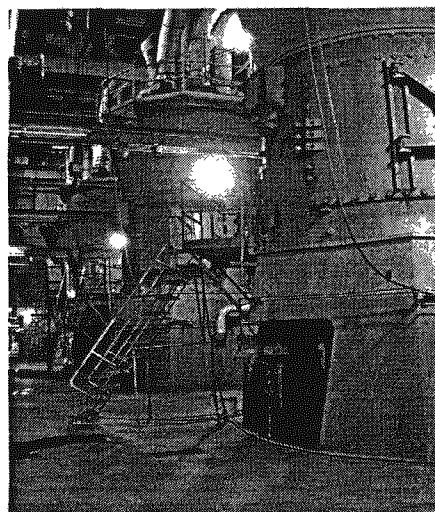
U2 Burner Replacement (ABT)

- Scanner Replacement (ABB)



Pulverizers- design

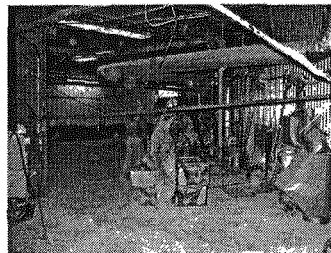
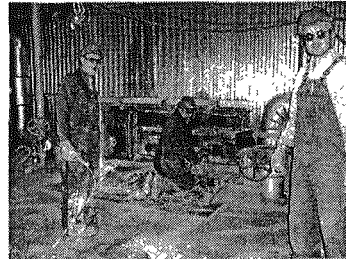
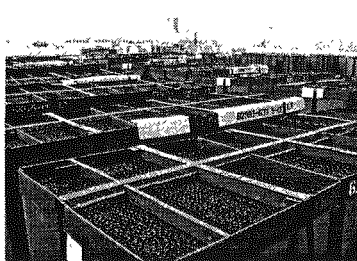
- Babcock & Wilcox
- 8 Model MPS-89G
- 65 TPH Capacity Each



Ongoing Pulv enhancements-
Rotating throats, static classifier
(separate discussion)

26

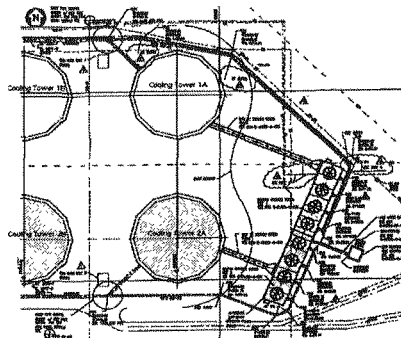
Sec Air Heater- Basket Replacement



27

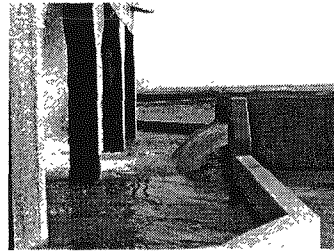
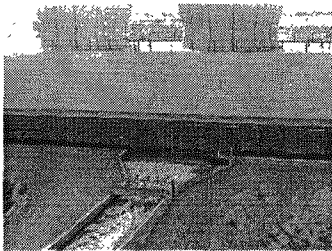
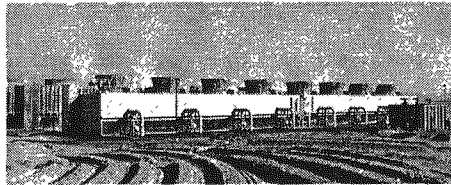
Heat Rejection System- added Help CT

- Turbine Heat Rejection System Enhancements
- Problems with original CT capacity & performance
- Heat output increase of 8.5 %
- Best Approach- Helper Cooling Towers
- 15 % Increase in Heat Rejection
- Additional circulating water flow with circ water pump impeller upgrade

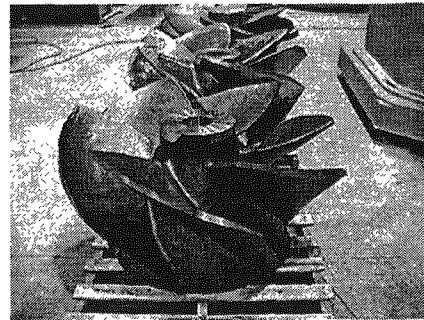
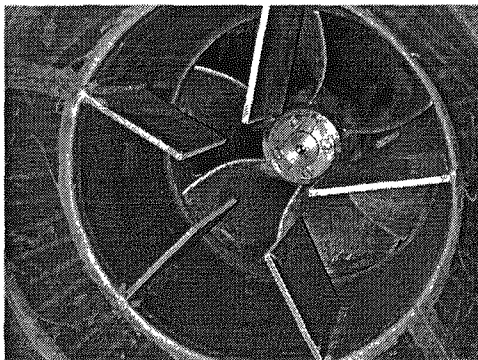




HELPER COOLING TOWER- LAYOUT

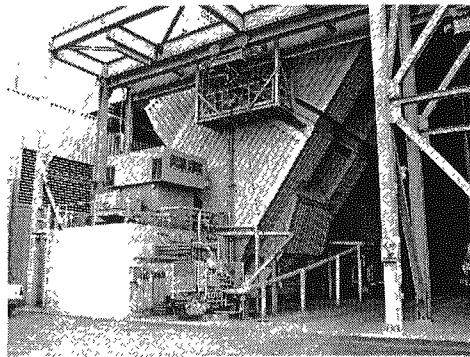
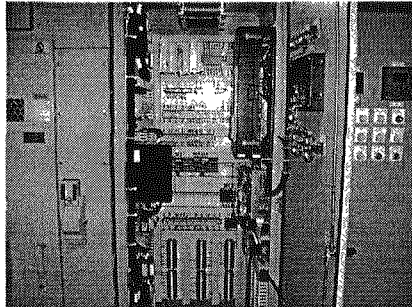


Circ Pump- Impeller Upgrade



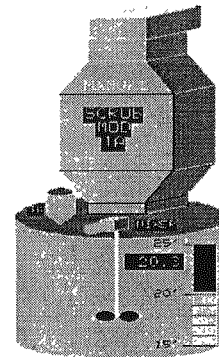
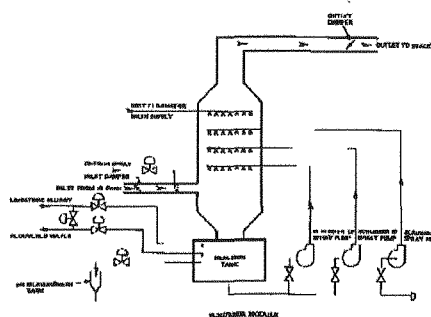
30

Induced Fan- Variable Speed Drive Replacement



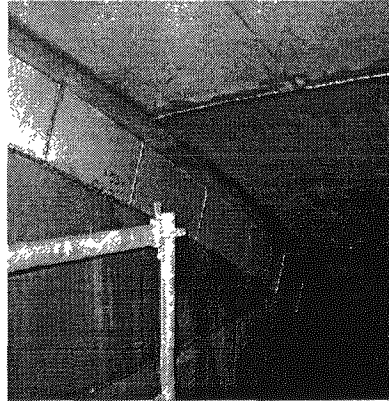
Scrubbers- design

- 6- GEESI Wet Limestone Absorber Towers
- Minimum 90% SO₂ Removal
- Max Emission Rate 0.150 lb SO₂/MMBtu



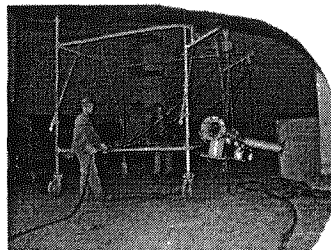
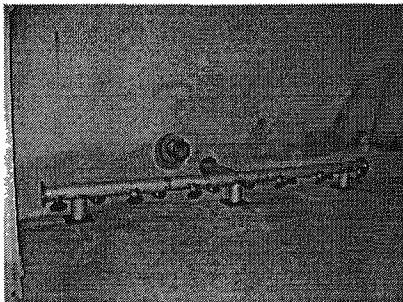
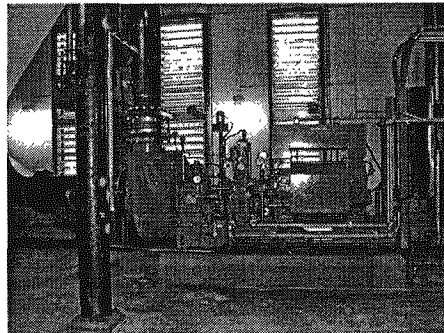
Scrubbers- upgrade

- Wet SO₂ Scrubber Enhancements:
- Wall cladding in each absorber module
 - original was block lined carbon steel
- Wall Ring Installation
 - redirect sneackage flow
- Forced Oxidation System
 - address higher sulfur coal improves sulfate production for scrubber & sludge conditioning



Scrubber- Forced Air Oxidation System Addition

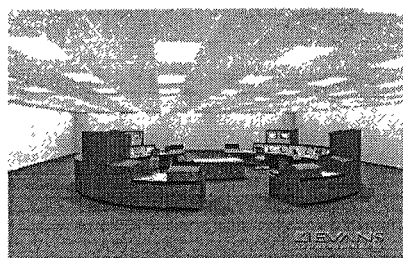
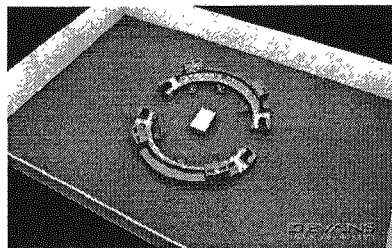
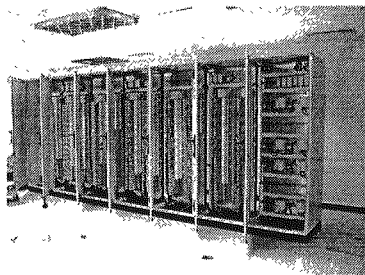
- Forced Oxidation Header
- Forced Oxidation Piping
- Air Compressor and Motor



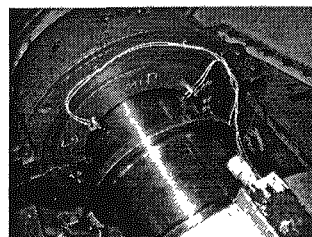
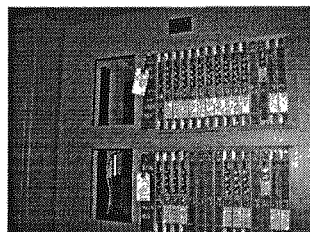
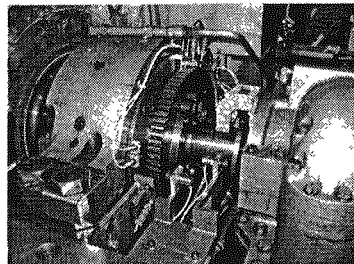
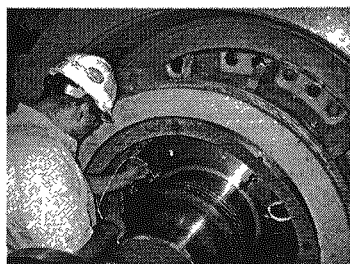
34

Digital Control Systems (DCS)- replacement

- Phase 1- information computer
- Phase 2- simulator
- Phase 3- control system



Turbine- Vibr & Thermal Stress Instr upgrade



Plant Equipment Evaluation

Mechanical Systems- other modifications

- Boiler Feed Pumps- upgraded
 - Higher efficiency and capacity
 - Modified to a straight-edge impeller allowing same capacity at reduced speed

Electrical Equipment- other modifications

- Generator- No Upgrade Needed
- Isophase Bus
 - Forced Cooling Added

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OPERATIONAL IMPACT

TRADEOFFS- Pushing it to “The Edge”

- Advantages- \$
 - Increased Generation
 - Improved Performance
 - Increased Revenue (bottomline)
- Disadvantages- RISK
 - Expect more unit derates due to pulvs & coal quality
 - Possibly more forced outages due to tube leaks
 - Higher auxiliary power requirements

38

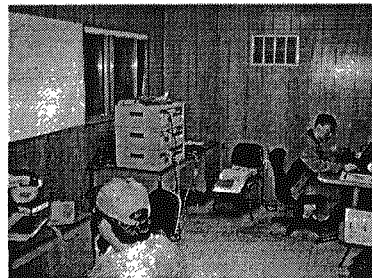
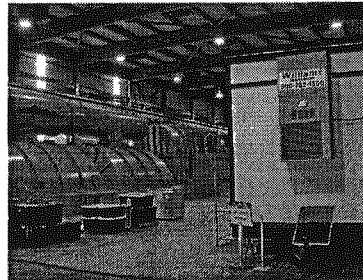
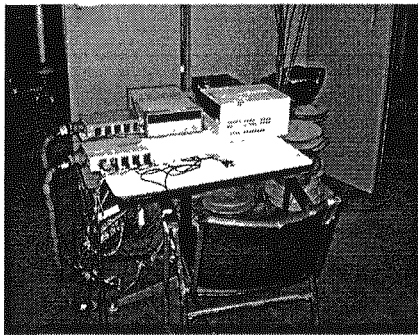
OPERATIONAL IMPACTS

- Unit Startup
 - added 4 hrs to cold startup
- Performance/ Acceptance Testing
 - Turbine & Turbine Cycle
 - Overfire Air & Burners
 - Boiler Platens & Sec Air Heaters
 - Helper Cooling Towers
 - Circulating Water Pumps
 - Boiler Feedpumps
- Environmental Regs & Compliance
 - Demonstration Test Requirements for NOx & CO

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Turbine Performance Testing

ASME 6.1 Simplified Turbine Testing
- 3rd party instrumentation

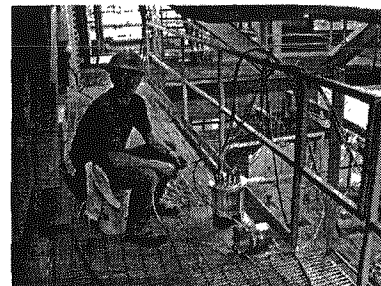
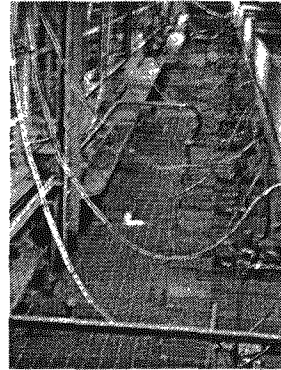
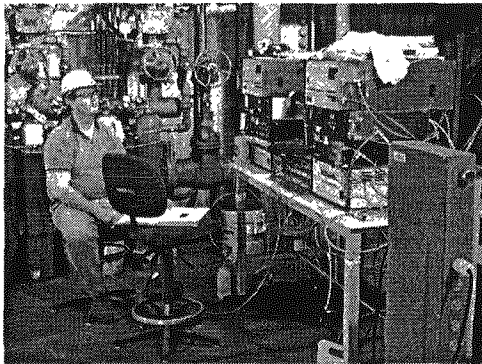


40

Boiler Performance Testing

ASME Boiler Tests

- rented 3rd party instrumentation



Upgrade- RESULTS

Gotten everything we had hoped for!!

- Both Units running at 950 MWg
- MCR testing show 985 MWg capacity
- Turbine Performance Testing- passed
- Performance Testing on other Equipment showed achieved expected performance levels
- Boiler and Overfire Air Tests
 - demonstrated expected results with NOx reduction, however, new CO targets were tougher to achieve

42

HP Turbine- Incentives and Penalties for Schedule and Performance Guarantees

RESULTS- Performance guarantee

- HP Efficiency 0.6 % better
- HP Turb Wheel Power 10.7 MW higher

Schedule

- Turbine Delivery Schedule no penalties

43

Environmental Compliance

- Station Enhancements considered a Minor Modification using the WEPCO Rule
 - court ordered rule change 7/92 (Fed. USEPA)
- WEPCO Rule eliminated the need for Best Available Control Technology (BACT)
- First project in State to use this exemption
- WEPCO Rule can only be used if the project does not result in a "significant increase" of emissions

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WEPCO Rule Applied

- Future annual emission levels will not exceed actual levels by significant amounts (historical ave emission tonnage + 40 tons)
- Permitted emission rates will decrease to maintain total annual emission levels

45

SUMMARY OF ENVIR CHALLENGES

- Being a good environmental custodian we ran well below our required emissions limits on NOx, SOx & particulate
- State emission limit changed from a rate to a historical average tonnage, plus new rate 30 day rolling average method
- Station vs Unit limits questioned. Unit basis- sectionalized Maint (4 weeks every 2 years, off year may not have an Outage, so required to run rate lower to compensate)
- Fuels Group change in coal quality- HHV coal okay, but higher sulphur & nitrogen content (higher fuel bound NOx)

KICKER

- Overfire Air use not allowed for NOx reduction in WEPCO accounting
- State approved Overfire Air modification on condition meets new CO criteria (CO regulated pollutant but not measured). Requires initial and annual demonstration testing.

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NOx Versus CO & LOI

Competing Goals

- Previous NOx limit of 0.50 Lbs/MBTU was not difficult to reach
- Boiler tuning and operation directed towards ash Loss On Ignition (LOI) reduction (hist ave 0.40%) and fly ash sales
- Excess oxygen targeted at 2.7% (boiler design 3.2%)
- Decreasing excess oxygen reduces NOx emissions but CO and LOI's increase

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CHALLENGE

Engineering

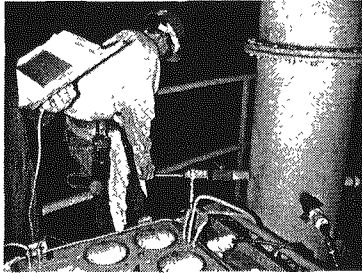
- Need to control fuel to air ratio at each individual burner
- Balance coal burner lines. Installed dynamic restrictors and conducted on-line balancing based on dirty air tests
- Balanced secondary air flow thru each burner register

Operations

- What are the targeted Emissions Rate for NOx, CO & SO2?
- Setup a backcalc method based on what has been emitted, time and coal quality left and how many days left in WEPCO period (based on scheduled maint outages).
- Developed NOx & CO control strategies based on available operating parameters.

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Burner Dirty Air Flow Testing



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SUMMARY

- Upgrade Project completed on schedule, within budget and operates as expected
- Economical approach to increasing plant output and improving station performance
- With new equipment technologies, upgrades can be utilized to enhance existing systems
- Cover all your bases and get feedback from Operations, Maintenance and Environmental groups
- Try to interface with the State Regulators and get prior commitments before starting project

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FUTURE IMPROVEMENTS

- Generator Excitation Replacement
- Generator Rewind
- **IGS Unit 3-** Final Leg of Environmental Permitting Process

51

MAJOR OPERATIONS ACTIVITIES

- IPP Facility Security



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